

NOTES ON AUSTRALIAN MOSQUITOES (DIPTERA, CULICIDAE). IV.  
AËDES ALBOANNULATUS COMPLEX IN VICTORIA.

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(Four Text-figures.)

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*Synopsis.*

The present study has revealed that *Aë. alboannulatus* complex in Victoria consists of six forms. A comparative account of the biology and ecology of *Aë. queenslandis* and of the new forms is given. The taxonomic status of three forms is discussed. Adults of both sexes and the larvae of *Aë. rupestris*, n. sp., and *Aë. tubbutiensis*, n. sp., are described. An account is given of the variability of *Aë. queenslandis* (Strickl.) and notes on *Aë. alboannulatus* (Macq.) are added.

Most species of the *alboannulatus* group are distributed in the Oriental region and in the northern part of the Australian region. Only some species of *alboannulatus* s. str. subgroup (Knight and Marks, 1952) extend south into Victoria, South Australia and Tasmania. The two most common species of this subgroup, *Aë. alboannulatus* and *Aë. queenslandis*, have been previously recorded from Victoria (Edwards, 1924).

*Aë. alboannulatus* varies very little over its range of distribution and only one conspicuous variation, a yellowness of the apical part of the femora, has been found; this variety occurs in the western part of the Otway Ranges.

*Aë. queenslandis*, on the other hand, has been regarded as a highly variable species. A detailed study of specimens from Victoria has confirmed this opinion, but has also shown that the name *Aë. queenslandis* has, in the past, been applied to a complex of closely related forms. In addition to *Aë. queenslandis* four others can be recognized. Three of them have different geographical and/or ecological distribution and do not interbreed where their distribution overlap. Two are treated as species and are described below under the names *Aëdes rupestris* and *Aëdes tubbutiensis*; the third (Form A), which is undoubtedly a distinct species, will not be discussed here since it has already been reviewed, though not as yet named, by Lee, Dyce and O'Gower (1957). The fifth member of the complex, which will be referred to as the "yellow form", appears not to be reproductively isolated from *queenslandis* and will be treated as a variety of this species.

*Key to Victorian species of alboannulatus complex.*

*Adults.*

1. Tibiae and proboscis mottled with pale scales ..... 2.
- Hind tibiae and proboscis black ..... 3.
2. Scutum with patches of white scales. Femora with ochreous preapical ring, which may extend apically. Posterior pronotum with bronzy narrow scales dorsally. Venter white with median black spots ..... *alboannulatus*.
- No patches of white scales on scutum. No preapical ring on femora. Posterior pronotum with pale goldish narrow scales dorsally ..... *tubbutiensis*, n. sp.
3. Tibiae with white sub-basal ring ..... form A.
- Tibiae without sub-basal ring ..... 4.
4. Venter ochreous usually with scattered black scales ..... *queenslandis*.
- Venter black with white lateral patches. Apical border of sternites always with broad black band ..... *rupestris*, n. sp.

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*Larvae.*

1. Head setae 4, 5 and 6, almost in straight line. Prothoracic seta 1, 2-branched; 4, single; 5, 2-3-branched ..... *rupestris*.
- Head setae 4, 5 and 6, forming triangle. Prothoracic seta 5, single ..... 2.
2. Head setae 4, 5 and 6, forming almost a right angle, with setae 4 well in front of setae 5. Prothoracic seta 1, 2-branched; 4, single ..... *alboannulatus*.
- Head setae 4, 5 and 6, forming obtuse triangle with setae 4 slightly in front of or behind setae 5 ..... 3.
3. Prothoracic seta 1, 2-branched; 4, 2-branched, rarely single ..... *queenslandis*.
- Prothoracic seta 1, single, rarely 2-branched on one side; 4, 2-3-branched ..... *tubbutiensis*.

Distinguishing the larvae of *rupestris*, *alboannulatus* and *queenslandis* is not difficult, but the larvae of *tubbutiensis* are very similar morphologically to those of *queenslandis* and some cannot be identified with certainty.

## AËDES ALBOANNULATUS (Macquart).

*Culex albo-annulatus* Macquart, 1849, *Dipt. Exot.*, suppl. 4: 10.

*Distinctive Characters:* Adult. Vertex clothed with narrow curved bronze scales becoming white towards centre of vertex. Proboscis mottled. Scutum clothed with narrow, curved bronze scales and some patches of white scales. Posterior pronotum with narrow curved bronze scales dorsally. Femora with preapical band; femora and tibiae mottled. Sternites white scaled with median patch of black scales.

*Description of Adult.*

*Female.*—Head: Vertex clothed with narrow curved bronze scales except for small median area of white scales. Upright scales black; lateral scales broad and white except for large black patch in middle. Palpi black scaled with white scales on base of segments and on apex of last. Proboscis black scaled, mottled or pale scaled in middle. Scutum clothed with narrow curved bronze scales with some small areas of white scales; a patch of broad white scales just in front of scutellum. Anterior pronotum with narrow curved and elongate white scales and black bristles. Posterior pronotum with broad white scales below, broad black scales in middle and narrow bronze scales above; black area may have a few pale scales. Tergites black with incomplete white basal bands and lateral spots. Sternites white scaled with median and lateral apical black spots. Wing length: 5.0-7.5 mm. Upper fork cell 1.5-2.3 times as long as its stem. Legs: femora with preapical band or patch, which may join with knee spot. Tibiae mottled. Fore and mid tarsi with 2-3 white basal rings, hind tarsi with 4.

*Male.*—Palpi about as long as proboscis without labella; last two segments, and apex of shaft, with long, dark, silky hairs; a white spot at base of each segment. Proboscis less mottled than in female, sometimes only a few white scales. Upper fork cell 1.3 times as long as its stem. Tergites 2-7 with complete white basal bands; 2 may have only a patch of white scales; tergite 8 may be mottled. Sternites usually black with lateral white spots; white scales may predominate and black scales be reduced to patches in middle of segment and apical corners. Terminalia: very similar to terminalia of *queenslandis* and can be recognized only by the basal lobe of the coxite (Fig. 1, *a*) which has a row of about 20 setae instead of 10 as in *queenslandis*. Appendage of harpago not as expanded in middle as it is in *queenslandis*. Ninth tergite with prominent lobe bearing 2-5 strong setae.

*Larva.*—Head and siphon brown. Head about five-sevenths as long as broad. Antenna about half length of head, clothed with spicules; seta 1, 3-5-branched, arising at about half-way from base. Head seta 4, 4-5-branched; 5, 3-5-branched; 6, 2-4-branched; 7, 6-7-branched; 8, 1-2-branched; 9, 2-3-branched. Head setae 4, 5 and 6 arranged to form apices of almost right angle triangle (Fig. 1, *d, c*). Seta 4 medial to 5 and 6 and between them. Mentum with 9-12 lateral teeth. Prothoracic setae (Fig. 1, *b*): 1, 2-branched; 2, single, only slightly shorter than 1; 3, 4-5-branched, about three-quarters length of 2;

4, single, about as long as 3; 5 and 6, single; 7, 3-branched. Eighth abdominal segment: Pentad setae: 1, 3-5-branched; 3, 8-11-branched; 5, 4-6-branched; 2 and 4, single. Comb of large patch of fringed scales. Siphon index: 2.6-3.4, mean 2.9; seta 1, 6-7-branched. Pecten of 17-20 spines, each with 3-4 teeth at base, central ones the largest. Anal segment: saddle covering about half segment. Seta 1, single or 2-branched; 2, 5-8-branched; 3, single; 4, of 15 tufts. Anal papillae about as long as saddle, or shorter. Eggs (Fig. 1, *g*) black, narrow, slightly flattened ventrally, about 1.0-1.1 m. long with an index of about 4.

**Biology:** *Aë. alboannulatus* is a sylvan species. It occurs almost throughout Victoria, but has not been recorded in the Mallee. It breeds in ground pools and rock pools; the water is usually clear but may be more or less cloudy. *Aë. alboannulatus* usually avoids heavily shaded pools in dense forest, showing a preference for diffuse

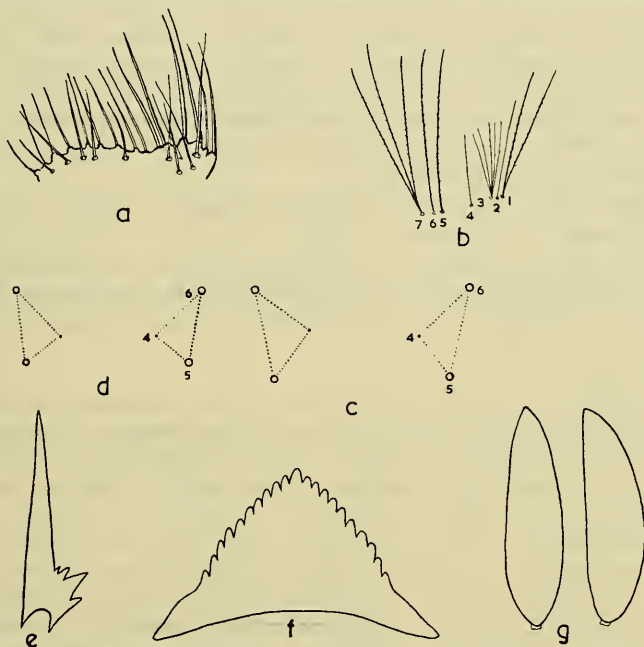


Fig. 1.—*Aëdes alboannulatus* (Mocq.). Adult: *a*, basal lobe of coxite. Larva: *b*, prethoracic setae; *c* and *d*, bases of head setae 4, 5 and 6; *e*, pecten tooth; *f*, mentum; *g*, egg, plan and side view.

sunlight. On the Bogong High Plains, at an altitude of 5,400 ft., it was found during the summer to be breeding in ground pools fully exposed to the sun. In the flat country north of the Dividing Range it can use such pools only during the cooler months of the year, being confined during the summer to shaded gullies, backwaters and roadside ditches.

The spring generation of *alboannulatus* oviposits on the edges of pools many of which will dry during the summer; the eggs then remain dormant until autumn rains fill the pools again when most of the eggs hatch within 12 hours. Some larvae pupate and produce adults, early in August, but the majority do not pupate until the spring. In permanent water pools *alboannulatus* is able to breed all the year round.

Adults are always abundant during the spring, and commonly during the autumn in favourable places, but a prolonged dry summer may result in the drying out of pools which in normal years permit continuous breeding.

In Victoria *alboannulatus* is sometimes found breeding alone, but usually it is associated with *Aë. queenslandis*, *C. fergusonii* Taylor, *C. pipiens australicus* Dobr. and Drumm., *Th. inconspicua* Lee and *A. annulipes* Walk.



*Habits:* The adults are vicious day-biting mosquitoes; they bite even during the winter at temperatures as low as 11°C.

AÈDES QUEENSLANDIS (Strickland).

*Culicelsa queenslandis* Strickland, 1911, *Entomologist*, 44, 179. *Culicelsa similis* Strickland, 1911, *ibid.*, 44, 132. *Culicada demansis* Strickland, 1911, *ibid.*, 44, 202. *Culicada cumpstoni* Taylor, 1914. *Trans. Ent. Soc. Lond.*, 1913, 692. *Culicada hybrida* Taylor, 1916. *PROC. LINN. Soc. N.S.W.*, 41, 568.

This is a rather variable species, and hence it is difficult to specify morphological traits which are common to all variants.

*Distinctive Characters:* Adult, Female.—Vertex with large or small area clothed with golden-yellow scales. Proboscis black scaled. Integument from light brown to dark brown. Thorax clothed with narrow light yellow or bronze scales; no patches of broad white scales in front of scutellum. Posterior pronotum with patch of broad white scales below, broad black scales in middle and goldish, narrow, curved scales above. Tarsi of fore and mid legs with two basal white bands, hind legs with four. Tergites black with incomplete yellowish basal bands, sometimes reduced to a few pale scales. Sternites clothed with ochreous scales; lateral apical spots of black scales, or of black scales and ochreous mixed.

Male.—Sternites black scaled with lateral elongate white spots; black apical part of sternites with some ochreous scales.

Larva.—Head setae 4, 5 and 6 arranged to form apices of a triangle; setae 4 lie between setae 5 and slightly in front of or slightly behind a line drawn through them. Prothoracic seta 1, 2-branched; 4, 2-branched or single, shorter than 3; 5, single.

*Description of Adult.*

Female.—Head: Vertex usually with large patch of golden yellow scales. In Tasmanian specimens this patch greatly reduced and all upright scales black. Proboscis black scaled. Thorax: Integument usually light brown, but dark brown in Tasmanian specimens. Scutum clothed with narrow curved golden yellow scales. Laterally, particularly in area near scutal angle, there is admixture of dark bronze scales. Scutum of Queensland specimens clothed with almost uniform goldish yellow scales; in Tasmanian specimens it is mainly clothed with dark bronze, almost black, scales, with yellowish bordering scales. Prescutellar area without broad scales. Anterior pronotum with yellowish narrow curved and elongate scales and bristles; in some specimens, particularly Tasmanian, bristles on dorsal part of anterior pronotum are dark, almost black. Posterior pronotum with patch of broad white scales below (yellowish in some Queensland specimens), broad black scales in middle and goldish yellow narrow curved scales above. South Australian and Tasmanian specimens have some pale broad scales in black middle area. Area of narrow yellowish scales reduced in some specimens to a line, but in others it extends downwards, reducing the black area. Pleura with usual patches of broad creamy scales and bristles. Wing length 3.2–5.4 mm. Upper fork-cell 2.3–3 times as long as its stem. Fore and mid femora black with mottling of yellowish scales, except for ventral side of basal two-thirds, which is pale scaled. Hind femur pale on basal half, black with yellowish mottling on apical half. In some specimens mottling increased towards end of femur and forms small or large ochreous preapical patch or ring; in some specimens apical part of femur is yellow. Tibiae black, pale scaled posteriorly, sometimes with streak anteriorly. In a few specimens hind tibia with inconspicuous or incomplete white ring at base. First 2 or 3 tarsal segments of fore and mid legs with white bands; tarsi of hind leg with 4 bands, some specimens with narrow fifth band. Band on segment 4 usually half length of segment, but in Queensland specimens it is only one-quarter–one-fifth of length of segment. Abdomen: Tergites black scaled with white lateral spots and incomplete yellowish basal band on tergites 2–6; in some specimens bands reduced to a few pale scales. Tergites 7–8 black or mottled with yellowish scales; in some specimens yellow

scales increased on tergites 6-8 replacing black scales. Sternites clothed with ochreous scales, with apical lateral black spots and usually mottling of black scales, the number of which sometimes exceeds yellow ones.

Male.—The male differs from the female as follows: Palpi black scaled, as long as proboscis without labella. Last two segments and apex of shaft with long dark hairs; segments 2-5 with patch of white scales. Torus brownish; flagellar segments pale, with dull silky verticillate hairs. Vertex clothed with narrow curved and upright yellowish scales. Thorax: Integument brown. Scutum clothed with yellow goldish scales with some admixture of dark bronze scales near area of scutal angle. Femur of fore leg black, mottled laterally and ventrally; femur of mid leg black mottled, pale scaled ventrally on basal half; femur of hind leg pale on basal two-thirds, apically black with few yellowish scales. Fore tarsi with 2 white rings, mid tarsi with 3, hind

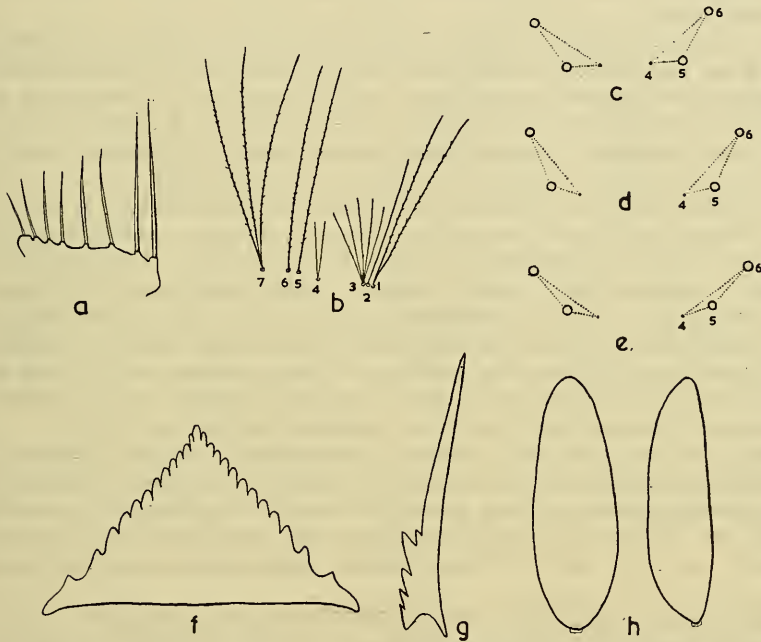


Fig. 2.—*Aedes queenslandis* (Strickl.). Adult: *a*, basal lobe of coxite. Larva: *b*, prothoracic setae; bases of head setae 4, 5 and 6 from: *c*, Queensland; *d*, Victoria; *e*, Tasmania; *f*, mentum; *g*, pecten tooth; *h*, egg, plan and side view.

tarsi with 4. Ring of segment 1 about one-fifth of segment. Tergites 2-6 with white basal bands, usually complete. Sternites black scaled with elongate lateral white patches not reaching apical border, and some yellowish scales scattered apically in black area. Terminalia: Coxite clothed basally with white scales and apically with black scales and golden bristles. Style about half length of coxite, narrowing to both ends, with 1-2 preapical setae, appendage slightly curved and about half length of style. Basal lobe of coxite narrow, transverse, with row of about 10 setae (Fig. 2, *a*). Harpago stout, with fine setae at base; appendage about as long as harpago, widened at middle and narrowing to end. Paraproct with single tooth and 5 fine setae. Ninth tergite with prominent lobe bearing 2-7 stout setae.

*Variability of Males.*—Scutal scales may be dark or light golden, with some admixture of dark bronze scales. In some specimens black scales occupy the greater part of the posterior pronotum. Upper fork-cell 1.4-1.7 times as long as stem. Sternites sometimes clothed with mixture of black, yellow and white scales in different proportions, or may have black median and lateral apical spots and white lateral spots.

## YELLOW FORM.

This form differs from other variations in its general yellow colour, but, although typical specimens are quite distinct from the type form of *queenslandis*, there are intermediates.

The yellow form is characterized by: Lighter integument. Proboscis with a few pale scales on basal half. Torus yellow, darker on inner side. Broad scales on lower part of posterior pronotum yellowish. Fore and mid femora intensively mottled with yellowish scales, hind femora yellowish with mottling of black scales. Fore tibia pale below, black above—mid tibia mottled with yellowish scales; hind tibia black above and apically, elsewhere yellow. Tarsi of fore and mid legs with 3 banded segments, hind with 4; band on segment 4 about one-fourth length of segment. Bands on tergites in females, reduced to yellow patches or absent. Last 2-3 tergites clothed with ochreous scales. Sternites clothed with ochreous scales and a few scattered black ones; apical lateral spots black.

*Larva*.—Head and siphon light brown. Head about three-fourths as long as broad. Antenna about half length of head, clothed with spicules; seta 1, 4-6-branched, about half length of antenna and arising about halfway from base. Head seta 4, tiny, 4-6-branched; 5, 4-9-branched; 6, 3-5-branched; 7, 8-10-branched; 8, single; 9, 2-3-branched. Setae 4, 5 and 6 arranged to form apices of triangle; setae 4 lie between setae 5, slightly in front of, or slightly behind, a line drawn through them (Fig. 2, c, d, e). Mentum with 12-13 lateral teeth. Prothoracic setae (Fig. 2, b): 1, 2-branched; 2, single; 3, 5-10-branched, about three-fifths as long as 2; 4, small, 2-branched or single; 5 and 6, single; 7, 3-branched. Eighth abdominal segment; Pentad setae; 1, 4-6-branched; 3, 8-13-branched; 5, 4-9-branched; 2 and 4, single. Comb, large patch of fringed scales. Siphon index 3.1-3.7; seta 1, 8-9-branched. Pecten of 19-26 spines, each with 4-5 teeth at base. Anal segment: saddle covering about half segment. Seta 1, 1-2-branched; 2, 6-11-branched; 3, single, long; 4, of 13-16 tufts. Anal papillae about as long as saddle.

*Eggs* (Fig. 2, h) black, oval, slightly flattened ventrally and narrowing to the posterior end. They are about 1.0-1.1 mm. long with an index of 3.2-3.6.

*Biology*.—*Aë. queenslandis* is confined to woodlands. It breeds in swamps, ground and rock pools, dams, cavities in logs, and in artificial containers (tanks, tins, etc.), usually in shaded situations, since it requires water of relatively low temperature. It may make use of exposed shallow pools during the cooler months of the year, but in the summer can do so only at high altitudes; deep exposed pools are always more suitable.

In Victoria the temperature of the water in which *Aë. queenslandis* breeds has not been found to exceed 18°C., even during the summer, but in southern Queensland, where again shaded pools are preferred, the larvae may be able to tolerate higher temperatures; they have been collected (I. C. Yeo and H. Grening, 6.2.58) in pools exposed to the sun for several hours in which temperatures by mid-morning had reached 20°C.

The water may be clean or contain decaying leaves. In Victoria *queenslandis* sometimes breeds alone, but usually is found in association with *Th. inconspicua* Lee, *C. fergusonii* Tayl., *Aë. alboannulatus* Macq., and more rarely with *Th. littleri* Tayl., *A. stigmaticus* Skuse, *A. pseudostigmaticus* Dobr., *Aë. notoscriptus* Skuse, *Aë. rupestris* Dobr., *T. tasmaniensis* Strick., and with most of spring breeding *Aëdes* of the subgenus *Ochlerotatus*. During the coldest months development of larvae is slow, but a few pupae can be found almost throughout the winter. In the laboratory emergence of adults was observed at 10-11°C. *Aë. queenslandis* oviposits on moist soil or rock surfaces just above water level. The eggs cannot withstand severe desiccation, but in natural conditions, in forests, they remain viable throughout the summer and hatch after autumn rains fill the pools.

## AËDES RUPESTRIS, n. sp.

*Types*.—The type series were bred from larvae collected at Lorne. All specimens have their associated larval and pupal skins. The holotype female, allotype male, six paratype males and six paratype females are in the collections of the National Museum,



Melbourne. One paratype male and one paratype female are in each of the following collections: C.S.I.R.O., Division of Entomology, Canberra; School of Public Health and Tropical Medicine, Sydney; University of Queensland, Brisbane; British Museum (Natural History), London; U.S. National Museum, Washington.

*Distinctive Characters:* Adults.—Narrow curved scales on vertex goldish. Integument dark brown. Scutum with narrow dark golden and small areas of pale scales laterally. Scales in front of scutellum narrow. Femora mottled anteriorly. Proboscis and tibiae entirely black. Sternites black with white lateral patches. Apical border always with broad black band. Ninth tergite of male without prominent lobes. Larva: Head dark brown. Head setae 4, 5 and 6 with their bases about on a straight line. First and fifth prothoracic setae, 2-branched.

*Holotype Female.*—Head: Vertex with narrow curved decumbent scales, yellow goldish in centre. Upright forked scales yellow golden, becoming dark towards sides and neck. Lateral scales broad, flat and white except for central black patch. Torus black with patch of white scales; first flagellar segment of antenna pale at base with patch of white scales; other segments black. Palpi black scaled with patch of white scales on segment 2 and at base and apex of segment 3. Thorax: Integument dark brown. Scutum clothed with narrow dark golden scales, becoming pale around bare area, in front of wing roots, along border with posterior pronotum and anteriorly; admixture of black scales laterally. Scutellum pale scaled. Anterior pronotum with dark bristles, goldish curved narrow scales and broader elongate scales. Posterior pronotum with patches of broad white scales below, broad black scales in middle and narrow curved goldish scales above. Pleura with usual patches of broad white scales and pale bristles. Wing length: 4.2 mm. Upper fork-cell about twice the length of its stem. Stem of halteres pale; knob pale scaled except at tip and underneath, which are black scaled. Legs: Fore and mid femora mottled, pale ventrally on basal half; tarsal segments 1 and 2 with white bands, 3 with a few white scales at base. Hind femur pale ventrally on basal two-thirds, apical third black scaled with few white scales posteriorly. Hind tarsal segments banded, except last one. Band on segment 4 half length of segment. All legs with creamy knee spot and black tibia. Abdomen: Tergites black scaled. First tergite with apical patch of black scales; 2-5 with incomplete narrow white basal bands; 6 and 7 each with patch of pale scales. White lateral spots on all segments. Sternites black scaled with white lateral patches. Apical border of sternites always with complete broad black band.

*Paratype Females.*—The series of 11 paratype females does not show much variation. Length of wing varies from 3.6 to 4.3 mm. In some specimens tergite 1 has an apical patch of black scales mixed with a few white, 2 has a basal patch of white scales; 3-7 have complete, narrow bands. Sternites may be pale scaled with inconspicuous black scales, but apical black band is always conspicuous and complete.

*Allotype Male.*—This differs from the holotype as follows: Palpi black scaled, as long as proboscis without labella. Last two segments and apex of shaft with long dark hairs; 2-5 segments with patch of white scales. Torus black, flagellar segments pale, with dark silky verticillate hairs. Tarsi of fore and mid legs with 3 white basal bands, hind tarsi with 4. Wing length: 3.9 mm. Upper fork-cell 1.1 times length of stem. Abdomen: Tergite 1 with few dark and pale scales in middle, 2 with an incomplete basal band, 3-6 with basal bands joining white lateral spots, 7 with a few white scales at base, 8 with lateral white spots only. Sternites black with white elongate lateral spots not reaching apical edge. Terminalia: Coxite black scaled, with patch of white scales basally; laterally and sternally it bears long and some short setae. Style half length of coxite, narrowing sharply at mid length; 1-2 preapical setae; terminal appendage straight, about half length at style. Basal lobe of coxite narrow, transverse, with row of about 10 long setae along edge and several small ones on upper side. Harpago stout, with fine setae at base; appendage about as long as harpago, widened at middle and narrowing to end. Paraproct with single tooth and 2 very fine setae near tip. Ninth tergite without prominent lobe, a few fine short setae on inner side.

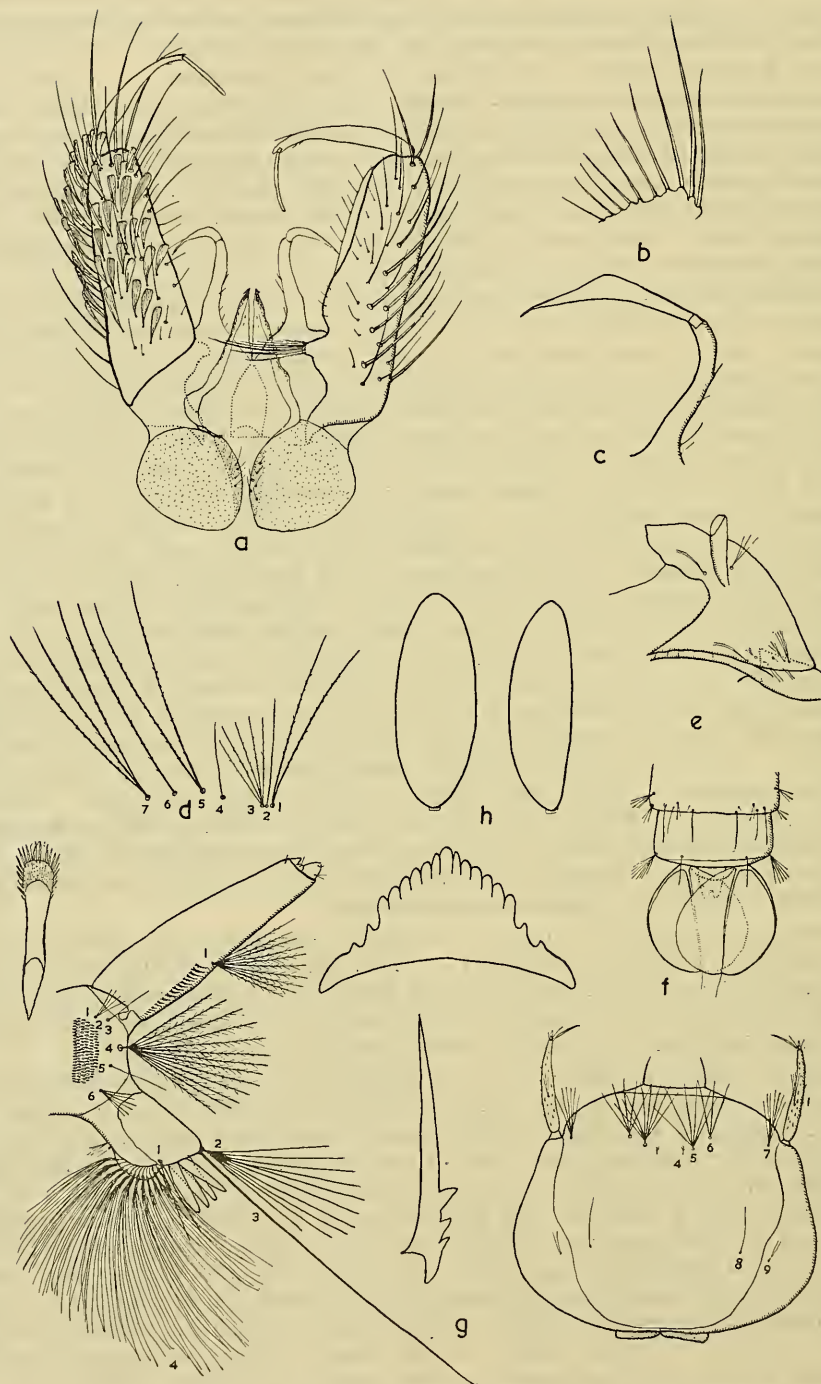


Fig. 3.—*Aedes rupestris*, n. sp. Adult: *a*, male terminalia; *b*, basal lobe of coxite; *c*, harpago. Larva: *d*, prothoracic setae; *g*, head, terminal segments and mentum. Pupa: *e*, part of cephalothorax; *f*, dorsal view of terminal abdominal segments; *h*, egg, plan and side view.



*Paratype Males*.—The series of 11 paratype males does not show much variation. The palpi of some specimens are slightly shorter than the proboscis. Some have only 2 tarsal bands on fore legs. Wing length: 3.6–3.9 mm. Sometimes tergite 7 has a complete basal band. White lateral spots on sternites are reduced in some specimens.

*Larva* (Fig. 3, *d, g*).—Head and siphon dark brown, body blackish. Head about four-fifths as long as broad. Antenna about two-fifths length of head, clothed with spicules, seta 1 with 2–4 branches, less than half length of antenna and arising at about two-fifths length from base. Head seta 4, tiny, 4–7-branched; 5, 5–7-branched; 6, 3–5-branched; 7, 5–10-branched; 8, single; 9, 2–3-branched. Setae 4, 5 and 6 with bases almost in a straight line. Mentum with 8–10 lateral teeth on each side. Prothoracic chaetotaxy: seta 1, 2-branched, long; 2, single, about three-fifths length of seta 1; 3, stellate, 5–11-branched and about half length of seta 1; 4, short, 1–2-branched; 5, long, 2–3-branched; 6, single, as long as 5; 7, 3-branched. Eighth abdominal segment: Pentad setae: 1, 3–4-branched; 3, 7–13-branched; 5, 5–7-branched; 2 and 4, single. Comb of about 150 fringed scales. Siphon stout, index 2.6–3.5, mean 2.9, seta 1, 6–10-branched. Pecten of 16–28 spines each with 2–3 teeth at base, the upper the largest. Anal segment: saddle covering more than half the segment. Seta 1, usually 2-branched, sometimes single; 2, 6–10-branched; 3, single, long; 4 of 14 tufts (one or two precratal). Anal papillae three-fifths to four-fifths length of saddle.

*Eggs* (Fig. 3, *h*) black, almost regular oval, flattened slightly on ventral side. They are about 1.0 mm. long with index 2.9–3.2.

*Biology*.—The breeding places of *Aë. rupestris* in Victoria are rock pools, in eucalypt forests, which are exposed to the sun. These are usually small and shallow with a thick layer of black mud and decayed leaves on the bottom. The water is brown, with a strong smell of decomposed eucalypt leaves. The temperature of the water in such pools rises during summer to about 30°C. at 1–2 p.m. In south Queensland the larvae of this species were collected, in large numbers, in two rock pools exposed to the sun; at 1–2 p.m. the temperature of water exceeded 37.5°C. (E. N. Marks, 19.11.57).

In some rock pools, particularly shallow ones with sloping edges, *Aë. rupestris* alone was found during the summer, but in these same pools, from late autumn to early spring, there were always some *queenslandis* larvae. In large and deep pools, with cleaner and cooler water, or with some vegetation, *queenslandis* was always more numerous than *rupestris* even during the summer. *Aë. alboannulatus* was found on several occasions in association with *rupestris*.

In south Queensland it was found in association also with *A. annulipes* Walk., *C. halifaxi* Theob. and *C. p. australicus* Dobr. and Drumm.

The eggs which remain dormant on the edges of dried pools hatch after being submerged by later rains. In the laboratory hatching of eggs was observed at temperatures in the range 9–14.5°C. At such low temperatures larvae developed only slowly, but eventually produced adults. Successful emergence of adults was observed in the laboratory at temperatures as low as 10°C.

*Habits*.—It is a day-biting mosquito, and is very common near its breeding sites; it ceases biting early in the winter when the temperature falls to 16–17°C.

*Distribution*.—Specimens have been bred from larvae collected at the following localities: VICTORIA: Franklin Riv. (6.3.53), Little Riv. and W. Tree Creek (north from Buchan, 17.1.56), Tubbut (17.1.56), Nowa Nowa (4.12.57), all in Gippsland, Warburton (18.3.58), Lorne (1955–1958), Meredith (11.3.54), all collected by the author; Grampians (26.9.53) (A. Neboiss). S. QUEENSLAND: Upper Cedar Cr. (19.11.57, E. N. Marks), Lamington National Park (16.2.58, I. C. Yeo), Canungra (13.3.53), Nambour (25.4.45, J. L. Wassell), Somerset Dam (29.10.46, J. L. Wassell).

#### AËDES TUBBUTIENSIS, n. sp.

*Types*.—The type series was bred from larvae collected at Tubbut (E. Gippsland). All specimens have their associated larval and pupal skins. The holotype female, allotype male, six paratype males and six paratype females are in the collections of



Fig. 4.—*Aedes tubbutiensis*, n. sp. Adult: *a*, male terminalia; *b*, basal lobe of coxite; *c*, harpago; Pupa: *d*, dorsal view of terminal abdominal segments; *e*, part of cephalothorax. Larva: *f*, prothoracic setae; *g*, head, terminal segments and mentum.

the National Museum, Melbourne. One paratype male and one paratype female are in each of the following collections: C.S.I.R.O., Division of Entomology, Canberra; School of Public Health and Tropical Medicine, Sydney; University of Queensland, Brisbane; British Museum (Natural History), London; U.S. National Museum, Washington.

*Distinctive Characters.*—Adult: Narrow curved scales on vertex pale. Proboscis mottled with white scales on basal two-thirds. Integument almost black. Scutum clothed with narrow dark bronze scales. Scales in front of scutellum narrow. Femora and tibiae mottled. Sternites white scaled with more or less conspicuous median black spot, or some mottling and apical lateral spots. Ninth tergite of male with prominent lobes and a few stout setae. Larva: Head dark brown. Head setae 4, 5 and 6 arranged to form apices of a triangle; setae 4 lie between setae 5 and slightly in front of line drawn through their bases. Prothoracic setae 1 and 4, single.

*Holotype Female.*—Head: Vertex with pale, narrow, curved scales. Upright forked scales pale in centre. Torus black with patch of white scales. First flagellar segment of antenna pale at base with patch of white scales; other segments black. Palpi black scaled with patch of white scales at base and at apex of segment 3; segments 2 and 3 with a few pale scales above. Proboscis black with mottling of white scales on basal two-thirds. Thorax: Integument almost black. Scutum clothed with narrow bronze and black scales, becoming pale around bare area near wing roots, on margins of scutum; two lateral pale patches near mid-length; scales in front of scutellum narrow. Scutellum pale scaled. Anterior pronotum with pale and black bristles, narrow curved, and elongate pale scales. Posterior pronotum with patch of broad white scales below, broad black scales in middle and narrow curved pale scales above; a few pale broad scales scattered in upper part of black area. Pleura with usual patches of broad white scales and pale bristles. Wing length: 5.6 mm. Upper fork-cell less than twice length of stem. Stem of halteres pale, knob pale scaled, except top and underneath, which are black scaled. Leg: Femora black scaled with white mottling; basal half pale scaled posteriorly. Knee spots yellowish. Tibiae black, mottled and with few white scales on base. Tarsal segments 1–2 of fore legs, 1–3 of mid legs and 1–4 of hind legs with basal white bands; bands on segment 4, half length of segment. Abdomen: Tergites black scaled. Tergite 1 with few pale and black scales in middle, 2–4 with incomplete basal white bands and lateral spots, 5–7 with bands joining lateral spots. Tergites 6–8 with scattered pale scales, increasing towards segment 8. Sternites white scaled with black mottling in middle and small apical, lateral spots.

*Paratype Females.*—The chief variations shown in a series of 11 females are: Size of pale spot on vertex may be reduced. Mottling of proboscis may be reduced to a few pale scales only. Mottling of hind tibia may be reduced. Basal bands on tergites may be reduced to small spots. Median black spot on sternites may be reduced; there may be only a few scattered black scales.

*Allotype Male.*—This differs from the holotype as follows: Proboscis black with occasional pale scales. Palpi about as long as proboscis including labella; last two segments and apex of shaft with long dark hairs. Patches of white scales on base of segments 2–5. Torus black; flagellar segments pale with dark silky verticillate hairs. Fore tarsi with 2, mid tarsi with 3 and hind tarsi with 4 basal white bands. Wing length: 4.0 mm. Upper fork-cell one and one-third times as long as its stem. Abdomen: Tergite 2 with narrow basal band, 3–6 with wide bands joining lateral spots. Sternites black scaled, with elongate, white lateral spots and a few white scales in middle of apical border. Terminalia (Fig. 4, *a*, *b*, *c*) of *Aë. tubbutiensis* is very similar to that of *Aë. queenslandis* and *Aë. rupestris*, but the styles are shorter—about one-third of the length of the coxite; first 4–5 setae of basal lobe about twice as long as those in *queenslandis*.

*Paratype Males.*—The chief variations shown in a series of 11 males are: Proboscis may be entirely black. The white lateral spots on the sternites may be small; white scales may extend from the lateral spots to the apical border and along it.



*Larvae* (Fig. 4, *f*, *g*).—Head and siphon dark brown; body blackish. Head about three-fourths as long as broad. Antenna about half length of head, clothed with spicules; seta 1, 4–5-branched, arising at about half-way from base. Head seta 4, tiny, 5–7-branched; 5, 5–7-branched; 6, 3–5-branched; 7, 7–10-branched; 8, single, rarely forked at apex; 9, 2–3-branched. Mentum with 10–12 lateral teeth on each side. Prothoracic chaetotaxy: seta 1 and 2 single; 3, 4–6-branched, as long as 2; 4, short, 2-branched; 5 and 6, single; 7, 3-branched. Eighth abdominal segment: seta 1, 4–5-branched; 3, 11–12-branched; 5, 6–7-branched; 2 and 4 single. Comb composed of large patch of fringed scales. Siphon index 3.1–3.7, mean 3.4; seta 1, 7–11-branched. Pecten of 20–30 spines, mean 25. Anal segment: saddle covering about half segment. Seta 1, single, may be 2-branched; 2, 6–12-branched; 3, single; 4 of 15–16 tufts. Anal papillae about as long as saddle.

*Biology*.—*Aë. tubbutiensis* breeds mainly in back water in creek beds and at times in rock pools more or less exposed to the sun. It avoids completely shaded pools (see Table 1).

TABLE 1.  
*The Habitats of Mosquito Larvae in Tubbut Area.*

Date.	Habitat.	<i>Aë. tubbuti- ensis.</i>	<i>Aë. queens- landis.</i>	<i>Aë. rupestris</i>	<i>Aë. albo- annulatus.</i>	<i>Culex douglasi.</i>	<i>Anopheles stig- maticus.</i>	<i>A. annulipes.</i>
17.1.56	Little River, ground pool exposed to the sun ..	14	—	—	—	—	—	—
20.1.58	Tubbut, ground pool exposed to the sun ..	36	1	—	—	1	—	—
15.3.58	" " "	26	—	1	—	—	—	3
16.4.58	Snowy River, small grassy ground pool ..	2	1	1	—	—	—	2
16.5.58	Sandy Creek, shaded ground pool ..	2	23	—	1	—	31	—
"	Sandy Creek, rock pool, exposed to the sun, 50 yards further on ..	10	6	38	—	—	—	—
"	Dam Creek, ground pool, short period of direct sun	7	2	—	—	—	5	1
"	Dam Creek, rock pool, exposed to the sun ..	11	—	7	—	—	—	—

*Habits*.—Adults were not collected in nature and there is no information on their biting habits. It can be expected that it will bite man as readily as do other Victorian members of this complex.

*Distribution*.—All known breeding places are situated in the north-eastern corner of Gippsland, in wooded country at an elevation of about 1,000 feet. This area has an average rainfall of 25–30 inches.

#### *AËDES* sp. form A.

This unnamed form, belonging to the *alboannulatus* complex, which has a white ring on the tibiae (Lee, Dyce and O'Gower, 1957), was found breeding alone in a rock pool with clean water and exposed to dispersed sunlight at Tubbut (17.2.56). It was breeding also at Little River (17.2.56) in a rock pool exposed to the sun, with slightly murky water and decayed leaves on the bottom; in this pool the dominant species was *Aë. rupestris*.

#### THE STATUS OF MEMBERS OF THE COMPLEX.

Comparative studies of *queenslandis* and *rupestris* have shown that the two species differ in both their morphology and ecology. The ecological differences seem to be largely a matter of different temperature preferenda.

During 1955-58, a study was made of larval breeding sites of the two species in the rocky valley of the Erskine River, near Lorne. In this particular place the river widens, forming shallow rapids with numerous rocky pools. These pools provide permanent breeding sites for *rupestris* even during the summer when the water temperature may exceed 30°C.; it never makes use of the cooler pools in the surrounding forest. The forest pools, 100-200 yards away, are the permanent breeding places of *queenslandis*. This species also uses the exposed rock pools during the cooler months, but in summer its larvae are only occasionally found in them, and then in the deeper ones.

The problem of why *queenslandis* larvae should be practically absent from the exposed pools during the summer has been investigated by means of laboratory experiments.

*Influence of water temperature on oviposition.*—Blood-fed females of *queenslandis* and *rupestris* were placed in cages of six cubic feet capacity containing two dishes (7" × 10.5") of water with wicks of filter paper covering the sides and providing oviposition sites. In one experiment, the temperature of the water in one dish was 17-18°C., in the other 27°C.; in the second experiment the temperatures were 14-15°C. and 30°C. Air temperature in the cages was 17-22°C. (Table 2).

TABLE 2.  
*Number of Eggs Deposited in Water of Different Temperatures.*

Species.	Temperature of Water.			
	17-18° C.	27° C.	14-15° C.	30° C.
<i>queenslandis</i> ..	—	—	563	0
<i>rupestris</i> .. ..	150	278	0	1347

From Table 2 it is evident that *queenslandis* would not normally deposit eggs on the edges of exposed rock pools during the summer; *rupestris*, on the contrary, would prefer these sites. Certainly in nature, during cold spells or cool evenings, when the temperature of water falls, *queenslandis* may deposit some eggs on the edges of the pools; these eggs, however, may be exposed to direct sunlight later on, and if there is no rain for some days the fall in water level may result in the eggs being subjected to desiccation.

*Resistance of eggs of queenslandis and rupestris to desiccation.*—Batches of 65 eggs of *queenslandis* and *rupestris* were placed on filter paper and exposed for different periods to a R.H. of 54-58% at a temperature of 20°C. In one experiment the eggs contained mature embryos, i.e., larvae ready to hatch; in a second experiment, immature embryos. After desiccation the filter paper bearing the eggs was immersed in water. The percentages hatching are shown in Table 3.

TABLE 3.  
*Ability of Eggs to Withstand Desiccation.*

	Exposure.	Percentage Hatch.	
		<i>queenslandis</i> .	<i>rupestris</i> .
Mature embryo .. ..	2 days	1.5	95.4
Immature embryo .. ..	12 days	13.3	98.0

It is clear that the fully embryonated eggs of *queenslandis* are unable to withstand even a brief period of desiccation. This, indeed, was apparent after 24 hours, for within that period 61.6% of eggs had collapsed and others had opened. Of the *rupestris* eggs, on the other hand, only 4.6% collapsed and none opened. The higher survival of

*queenslandis* in the experiment using eggs with young embryos can be attributed to the fact that these eggs did not open; the embryos were thus protected to some extent from desiccation.

In another experiment 125 eggs of each species were placed on wicks of filter paper about half an inch above water level (17–18°C.). During the next three weeks 56% of *queenslandis* eggs hatched and the larvae were able to wriggle over the moist filter paper into the water; *rupestris* eggs did not hatch.

In nature, during the summer, the hatching of *queenslandis* eggs above water level could often be fatal for the emerging larvae, but with favourable meteorological conditions, some might succeed in making their way into receding rock pools. They would then be exposed to water temperatures of 30°C. or more, which would probably be unfavourable for their development.

Work on the thermal death points of larvae of these two species is in progress.

As mentioned earlier, the *alboannulatus* group is distributed in the tropics and subtropics, and there can be little doubt that *queenslandis* and *rupestris* had their origin in the north. Both are sylvan species, but, as emphasized above, they have different temperature requirements. *Aë. queenslandis* became adapted to cooler conditions, and, having dispersed southwards, presumably along the ranges, is an abundant mosquito in cooler parts of south-eastern Australia. *Aë. rupestris* has been less successful in the south. Suitable breeding sites, that is, rock pools exposed to the sun, are not common in Victorian ranges, and, while large local populations of *rupestris* may be found, the distribution of this species is very patchy.

It is clear then that the morphological differences between *queenslandis* and *rupestris* are accompanied by physiological and ecological differences. However, the decisive factor in determining taxonomic status is reproductive isolation. The *queenslandis* and *rupestris* are sympatric forms (the area of distribution of *rupestris* lies entirely within that of *queenslandis*), but the examination of hundreds of specimens of both forms, from all known Victorian localities, has not revealed any intermediates. It is evident that the two forms are reproductively isolated and that *rupestris* should be regarded as a distinct species.

Both species bite man readily, but *rupestris* ceases to do so earlier in the year than *queenslandis*; early in June, when the temperature was 17°C., there were no biting *rupestris*, but *queenslandis* was scarcely less active than in the summer.

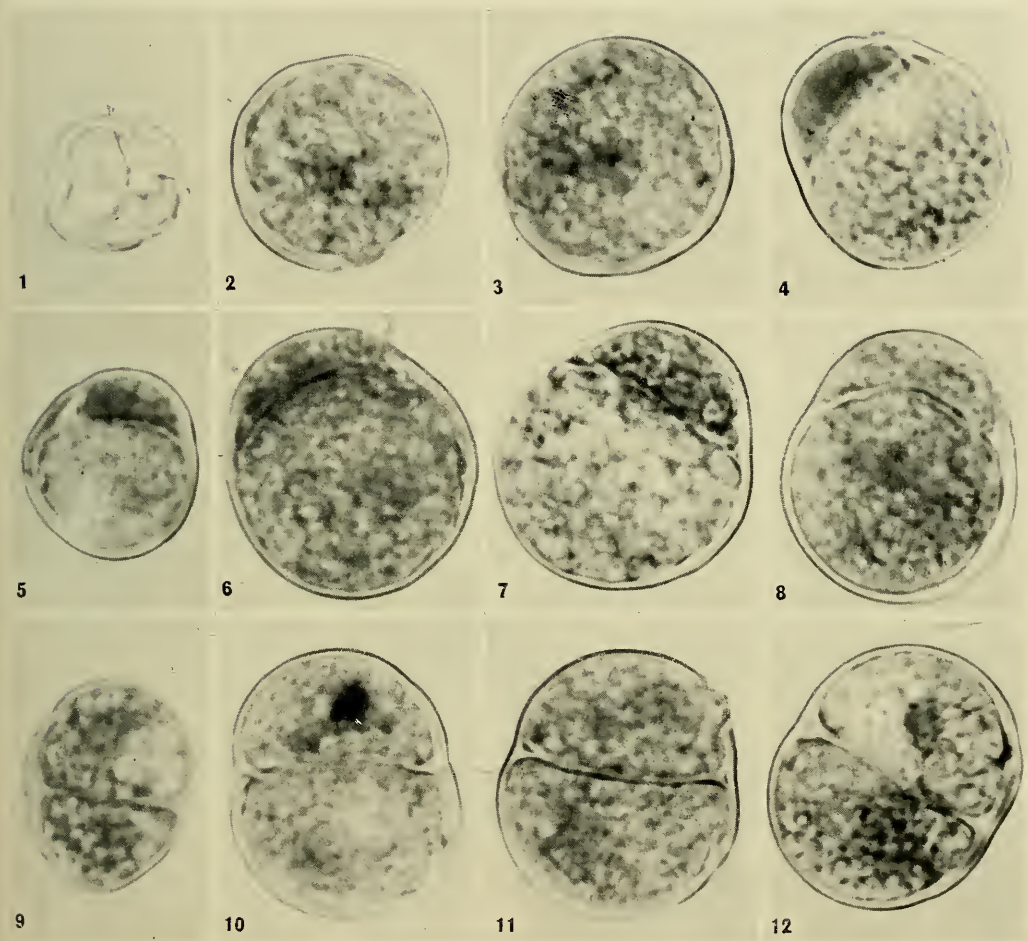
*Aë. tubbutiensis*, as far as we know, has a very restricted distribution; it has been recorded only in east Gippsland. *Aë. tubbutiensis* probably is more closely related to *queenslandis* than to the other species. Unfortunately, not much is known about the biology and ecology of this form, but it is apparent that it is more adaptable to higher temperatures than is *queenslandis*. *Aë. tubbutiensis* breeds mainly in ground pools, occasionally in rock pools, in the full sunlight or exposed to the sun for part of the day. Only once have adults of *tubbutiensis* (two females) been bred out from larvae collected from a shaded pool.

Examination of 121 adults and 70 correlated larval skins revealed only one female which could be regarded as an intermediate. Although *tubbutiensis* and *queenslandis* both vary considerably, there is not a continuous gradation between them.

If there were not reproductive isolation from *queenslandis*, intermediate forms should occur commonly. Mayr, Linsley and Usinger (1953) have stated, in relation to allopatric forms, "forms that hybridize only occasionally in the zone of contact are full species". The present author believes that this criterion can also be used for sympatric forms and thus can be applied in the case of *tubbutiensis*. As *tubbutiensis* is morphologically and ecologically distinct from *queenslandis* and reproductively isolated, it should be regarded as a separate species.

The yellow form of *queenslandis* merges into typical *queenslandis* and only extreme variants can be distinguished with certainty. The progeny of the females of the yellow





Breakdown of monad development in *Leucopogon virgatus*.